Full Length Research Paper

Status of the Swayne's Hartebeest, (*Alcelaphus buselaphus swaynei*) meta-population under land cover changes in Ethiopian Protected Areas

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This study aims to understand status and population structures of Swaynes' Hartebeest (SHB) (*Alcelaphus buselaphus swaynei)* meta-population under land cover changes in Maze National Park (MaZNP), Nech Sar National Park (NNP) and Senkele Swayne's Hartebeest Sanctuary (SHBS) from 2008 to 2009. A total, with direct count method based on silent detection of vehicles along roads was used to count SHB in the Protected Areas (PAs) within 5 blocks of the entire SHBS. In each of the lager MaZNP and NNP, 6 blocks were randomly sampled following habitat types such as grasslands. One wildlife expert, six scouts and one researcher were assigned to each of the block for counting the Hartebeest during early morning and late in the afternoon. A SPSS, Excel software and Landsat satellite imagery of the PAs was used for the SHB populations and land cover data analysis. Of the 840 SHB individuals recorded in these PAs, 364 occurred in MaZNP, 464 in SHBS and 12 individuals in NNP. The adult male SHB was 47% (MaZNP), 39% (SHBS) and 42% in NNP. The relationship between the adult males and adult females is highly significant for the MaZNP (2t=0.969, P<0.01). The study revealed that SHB population size is increasing in MaZNP and SHBS. However, there is dramatic decrease in the NNP. Since 1970s, the species population size has fluctuated from 865 to 480 to 840 in the PAs. This might be associated to decreases in grasslands such as from 75 to 48% in the MaZNP and 37 to 34% in the NNP during 1986 to 2005. Conservation measures that increase the population size of this endangered species is urgently needed to conserve the endemic species in Ethiopia.

Key words: Population size, Protected Areas, Status, Swayne's Hartebeest.

INTRODUCTION

Though most antelope species still exist in large number in the Sub-Saharan Africa, three quarter of the hartebeests are declining (Eastes, 1999). The hartebeests are large antelopes grouped in the Bovidae family. Of the nine sub-species recognized, two are extinct and the remaining seven are confined to dramatically contracted habitats (Lewis and Wilson, 1979). Previously, they occupied in a wider areas of Morocco up to north eastern Tanzania to south of Congo and from Southern Angola to South Africa. However, habitat destruction has drastically reduced their range. Therefore, at present, hartebeest occurs only in parts of Botswana, Namibia, Ethiopia, Tanzania and Kenya (Refera, 2005).

The term meta-population was first defined by Levins (1969) as sub-populations that exist in discrete habitat

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patches and the sub-populations may turnover with extinctions and re-colonization from other patches. Today, it has been used to define any population with spatial subdivision. In this paper, it is used to define spatial subdivision of Swaynei's Hartebeest (*Alcelaphus buselaphus swaynei)* in Ethiopia. Ethiopia's rugged topography and the varied climatic conditions have endowed it with spectacular wildlife species of scenery in Africa. Therefore, the country is responsible to protect these wildlife species that include endemic, endangered, vulnerable and rare species (Blower, 1969). Ethiopia harbors three sub-species of hartebeests (*Alcelaphus buselaphus)*: *A. b. lelwel*, *A. b. tora* and the endemic *A. b. swaynei* all of which are classified as endangered (Nobuko, 2004). The Swaynei's hartebeest (SHB), *A. b swaynei* is long-faced, having chocolate color of the three sub-species occurring in the country. SHB is normally seen in herds and characterized by a steeply sloping back. The hartebeest is a large ungulate ranging from 1.5 m to 2.45m in length and mass of 75 to 200 kg and both sex bears horns (Kingdon, 1989). Sexual maturity may occur as early as 12 month, but they attain maximum weight until 4 years (Kingdon, 1989). In the last few decades, at the beginning of the nineteenth century, SHB had been reported to be abundantly distributed from Somalia up to eastern part of the Rift Valley Lakes regions of Ethiopia. But currently, the number of SHB and its range has been drastically reduced in Ethiopia and believed to be exterminated outside its land. However, their population size has decreased and now endangered (Nobuko, 2004). Duckworth et al. (1992) described that the population size of SHB (*A. b. swaynei)* in Ethiopia was declining and it was a highly threatened endemic sub-species restricted to Ethiopia. The factors described for declining of the SHB population size includes human induced habitat destruction and fragmentations. Once, the total population of this hartebeest in Ethiopia was estimated to be 600 to 700 individuals (Bolton, 1973). Of these, large number of SHB populations existed in the Senkele Hartebeest Sanctuary (SHBS) during 1976 to 1988, ranging from 448 to 2379 individuals (Nobuko, 2004). With the objective to ensure the survival of the species, 90 individuals were transferred to Nech Sar National Park (NNP) and 120 to Awash National Park in 1974 from SHBS (Lealem, 1974). According to Duckworth et al. (1993), only 40 individuals of the species survived in NNP until 1992. Refera (2005) reported the occurrence of 242 to 277, less than 20 and 200 individuals of SHB in Maze National Park (MaZNP), NNP and SHBS, respectively. However, in 2008, the total number of individuals of SHB counted in SHBS was 283 for the wet season and 351 during dry season. In most part of the SHBS they used to occur, SHB showed a declining trend (Kumsa and Bekele, 2008). According to Vymyslická et al. (2010), 35 individuals of SHB existed in the NNP, where 23 individuals were in a reproductive herd (17 females and 6 males), three individuals in a temporary male bachelor group, and nine solitary males. Similarly, recent studies conducted on a five large antelope including SHB by Fetene et al. (2011) indicated existence of the 35 individuals in the NNP. Generally, studies have shown that the numbers of individuals of the SHB in the Ethiopian PAs were declining and continued to be rare. They were locally extinct in some of the PAs like in Awash National Park and at verge of extinction in the NNP. Consequently, the SHB is listed as an imminent danger of extinction and is completely protected by the law in Ethiopia (IUCN, 2002). At present, remnants of the endangered and endemic, SHB in Ethiopia are found in four separate localities, in SHBS, MaZNP, NNP and Alidige Wildlife Reserve (AWR). The major factors for its further decline, which hinders its conservation effort and increased threat, include high human population growth, intensive agriculture and livestock grazing that altered vegetation communities of the PAs. The SHB habitats have been surrounded by high human settlers and associated Livestock populations particularly with cattle. Competitions with the cattle for resource, mainly with grass, have increased in all the PAs that in turn deteriorated the grass and could increase in shrubby and other vegetation communities. In the MaZNP, the present population was estimated to 250 individuals but reliable data on trends, and status were not available. In this Park, the human population pressure was relatively less stressing though the number of livestock population was increasing. The human population pressure was more stressing in the SHBS as it was surrounded by human settler and high livestock population (Kumsa and Bekele, 2008). In the NNP, in addition to overgrazing with high livestock populations in one of the PAs, there was occasional poaching (Refera et al., 2003; Fetene et al., 2011). Thus, the population of SHB was not still doing well and categorized as globally-endangered species (IUCN, 2002). The factors such as intensive agriculture and livestock grazing within and around the PAs could alter land cover changes. We thus hypothesized that these factors may affect the land cover changes and could be attributed to the further decline in the population size, alteration in age and sex structures of the SHB in the PAs. The pressure on this species is still increasing due to a high demand to use the relatively intact vegetation remains within and around the PAs. Thus, understanding of the current status, population size, and age and sex structures of the species under changing land cover in the PAs is vital to prioritize and strengthen its conservation endeavors. Furthermore, it may be very difficult to prioritize conservation program for the species without well-documented scientific investigation of the current status, the dynamic population size, age and sex composition as related to land cover change. Therefore, the aim of this study is to investigate the current status and population structure of SHB in three Ethiopian PAs, namely MaZNP, SHBS and NNP in relation to land cover changes in and around the PAs.
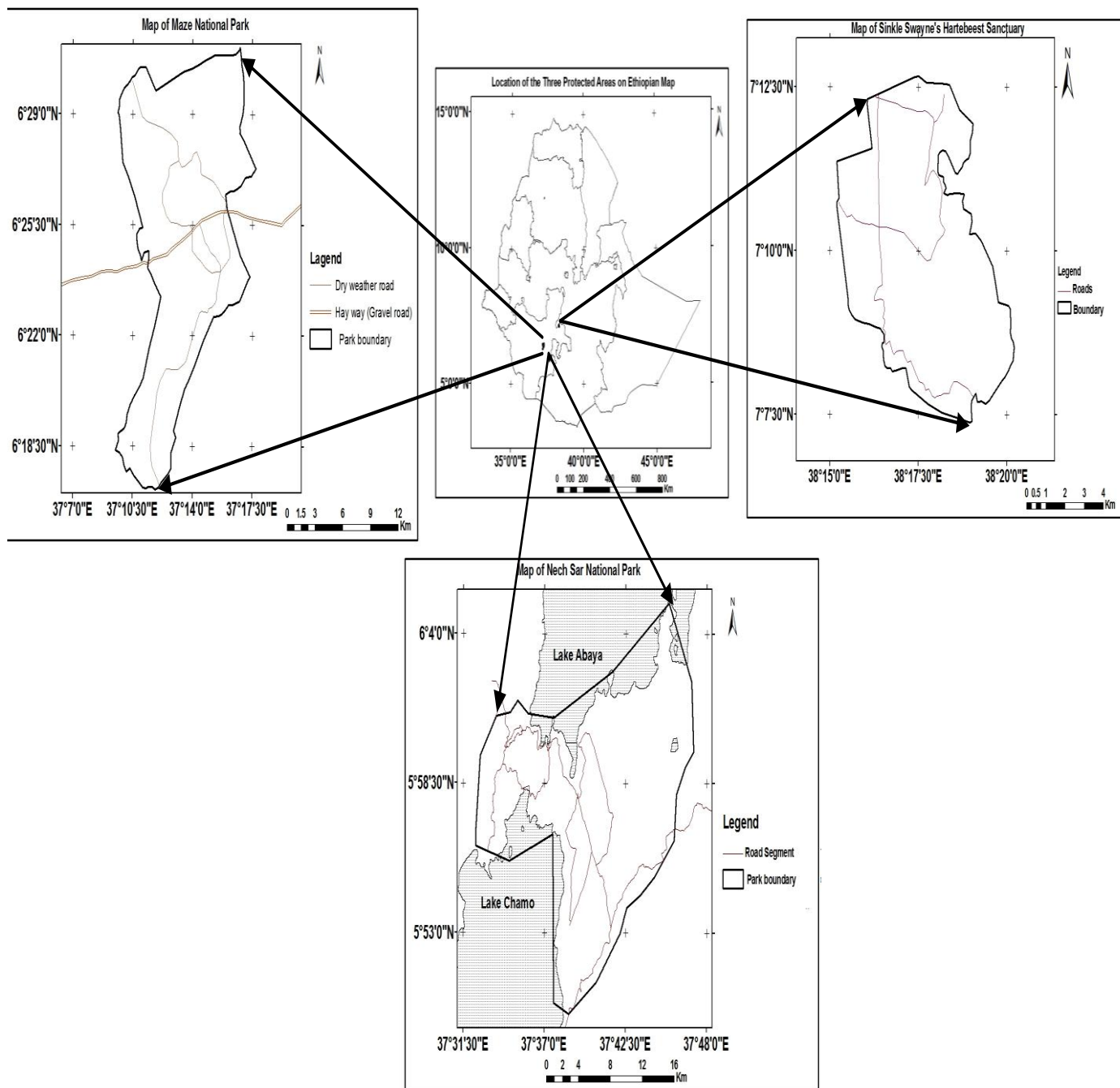
Figure 1. Map showing the study areas.

MATERIALS AND METHODS

Description of the study area

This study was conducted in MaZNP, SHBS and NNP (Figure 1). The MaZNP is found in Gamo Gofa Zone of Southern Nation Nationalities and People Regional States (SNNPRS) at 470 km from Addis-Ababa. MaZNP used to be a controlled hunting area and currently upgraded to a National Park. The total area of the Park is 202 km². Geographically, it is located at 6°17'31'' to6°31'30" N latitude and 37°09'00" to 37°18'00" E longitudes with an

altitudinal ranges from 1000 to 1200 m a.s.I (Figure 1). The socio-economic condition of the people is mainly agro-pastoralist. There is no meteorological station for the researchers to determine the climatic condition of the area. However, it is reported that, the rainfall pattern around Morka (the small town near the Park) is bi-modal type. There is a short rainy season from March to April while the main rainy season is from June to September. With regard to temperature condition, hot months are reported from November to February and cold months from June to September (Refera, 2005). The minimum temperature at Morka is 15.3°C and the maximum is 35.5°C (Refera et al., 2003). The majority of the National Park area

is characterized by plain topography and is dominated by *Compretum-Terminalia* community where the Maze River is the largest water system passing through it. The SHBS occurs between Oromiya and (SNNPRS) and covers an area of 57 km² (Information from Park office, 2011). It is found at 320 km from Addis Ababa in the western side of the Great Ethiopian Rift Valley (Eshetu, 2003). The sanctuary is one of the principal wildlife Conservation areas of Ethiopia (Hillman, 1993). Geographically, it is found between 7° 7'15" to 7°12'45" N latitude and 38°5'15" to 38°20'15" E longitude with the altitude ranges varying from 2000 to 2100 m a.s.l (Figure 1) (Messana and Netserab, 1994; Tekele, 1996). Vegetation types in the sanctuary are divided into savanna woodland, valley complex and grassland. The average rainfall at Senkele, measured over four years (1991 to 1994) is 1,116 mm (Kumsa, 2006). It has a moderately bimodal pattern of rainfall typical of the 'Woinadega' agro-ecological zone of Ethiopia. The three-month dry season, from November to January is followed by the 'Belg' rains, from March to April. During the dry season, cloud cover is at a minimum and wind speeds are at their annual maximum contributing to the high levels of evapo-transpiration associated with tropical climate patterns. The SHBS was established in 1976 to save the most viable population of the SHB, which are endemic and endangered sub-species (EWCO, 1990; Hillman, 1993; Messana and Netserab, 1994; Tedela, 1995). The extent of the Sanctuary has been declining from 200 km² in 1972 to about 58 km² in 1973, then to 36.4 km² and 28 km² (Messana and Netsereab, 1994). This reduction in area could be associated with human induced land cover changes where the surrounding farmers involved in agriculture and livestock converting land cover of the SHBS. But at present, its area has increased from 36 km² to 57 km² (Park office report, 2011).

The NNP is found at the center of Ethiopian rift valley floor between two lakes of Abaya and Chamo, 500 km south of Addis-Ababa in SNNPRS (Figure 1). It covers an area of 514 km², of which 78 km² is fresh water habitat and 436 km² of terrestrial habitats, composed of mosaic forest, open woodland and savannah grasslands (Fetene et al., 2011). NNP was established in 1974 and geographically located between 5°51' to 6°05' N Latitude and 37°32'-37°48' E Longitude with an altitudinal range of 1100 to 1650 m a s l (Bolton, 1973; Duckworth et al., 1992; Andarge, 2001; Svialek, 2008; Shimeles, 2010; Fetene et al., 2011). The climate of the study area is characterized by a relatively hot climatic condition with low and unevenly distributed rainfall pattern (Aregu and Demeke, 2006; Datiko, et al., 2007).

Studies also indicated that the NNP is rich in biodiversity harboring more than 90 mammalian and 350 species of birds. Moreover, the Park is used as destination point of many Palaearctic and intra-Africa migrants (Duckworth et al., 1992; Duckworth et al., 1993; Whitaker, 2007). There are two main river systems that flow through the park and form riverine forests and its woodlands. The Arba Minch ground water forest is a unique forest formation in Africa and is found in the western part of NNP. It serves as source of numerous natural springs locally known as 'Arba Minch' meaning forty springs. In the far eastern part of the park hot springs bubble to the surface (Duckworth et al., 1992; Andarge, 2001; Negussie, 2008). The soil of Nech Sar plains and surrounding bush land is black cotton soil with high clay content. According to Bolton (1973), the rugged mountains parts of the park have brown calereous loam derived from volcanic rocks. The soil ranges from patchy dark clay alluvial soils along the river basin to dominating dry cotton soils with poor drainage (Negussie, 2008).

Materials

In this study, 7x35 magnifying binocular, GPS, digital camera, and field guide for identification of the mammals, topographic map of the study area, satellite imagery data and field data sheets were used.

Swaynes' Hartebeest (SHB) population

Before conducting preliminary survey and actual data collection, all available literatures related to SHB and major habitats of the species were searched. The literatures were used to determine the previous population size, status and trends of the SHB population in the three Ethiopian PAs.

Preliminary survey to the PAs was carried out for ten days before the actual field data collection during February 2008. Based on the survey and literatures searched, the boundaries of different habitats in the Parks were identified and number of sampling blocks was determined. The number of blocks was determined separately for the three PAs depending on the size, type of vegetation and other land features of the PAs. First, each of the three PAs was divided into blocks following Norton Griffiths (1978), Sutherland (1996), Gebre (2000), Gebre and Yirga (2004) and Kumsa and Bekele (2008). For the smaller area, Senkele Hartebeest Sanctuary (57 km²), 5 blocks covering the entire census zone was used to count the SHB (Gebere, 2000). However, for the larger, MaZNP (202 km²) and NNP (436 km² of the terrestrial habitat), each of the PAs was divided to 6 sampling blocks (Norton-Griffiths, 1978) based on land cover features such as grassland, woodland, Shrublands and Valley that was also used as boundary demarcation. The area of the sample blocks for MaZNP and NNP was designed to cover 50% the Park areas, MaZNP at least 17 km² covered in each of the block and 40% of the area for NNP with at least 29 km² of one sample block.

The size of NNP is large but it is made 40% because the SHB in the Park is very low and found in restricted areas as compared to the denser SHB in the MaZNP. Therefore, counting of the lower densely populated SHB in NNP was easy by keeping the area searched lower. For counting the hartebeest, total count with direct observation based on silent detection was used following the methods described in Norton Griffith (1978), Melton (1983), Caughly and Sinclair (1994) and Sutherland (1996) and Gebre (2000). For the total count, various census groups or team of observers consisting of thirty persons were formed to count the SHB and complete counting within short time period.

The team for all the blocks of one of the PAs is composed of 20 scouts, five wildlife experts and five of the researchers. These counted the animals simultaneously so as to reduce or avoid double counting. In each of the block, a team of five to six persons (consisting of one wildlife expert, five experienced wildlife scouts and one of the researchers) was assigned depending on the size of the block. The block is bounded by patrolling roads or paths constructed within the protected areas in various directions along the different land features and these were used as boundary of the sample block: in case where no road or path, rivers, and ridge tope were used as the boundary of the block. The counting team approached the block in the different directions along the patrolling road constructed. Then the team members estimated SHB populations found in herds or counted those encountered in isolation. Similar counting method was used for the remaining PAs. In addition, vehicle was used to count SHB along the roads, paths and tracks constructed for patrolling purpose within and around the sample blocks in all the PAs. While counting, efforts were made to count or estimate the number of individuals of a herd.

During the field assessment indirect evidence of the animals (footprint, drooping and feeding signs) were also collected. Counting was carried out early (from 6:00pm to 10:00am) in the morning and late in the afternoon from 4:00pm to 6:00pm when the animals were active for sixteen days; eight days during the dry and eight days of the wet seasons. Of these, ten days was used for the on foot count and 6 days for the vehicle count. Herd estimation or counting of individuals seen was conducted using unaided eyes or binoculars on foot form vehicle on the counting blocks. The number of hartebeest counted and estimated was recorded on the data sheet prepared for this purpose.
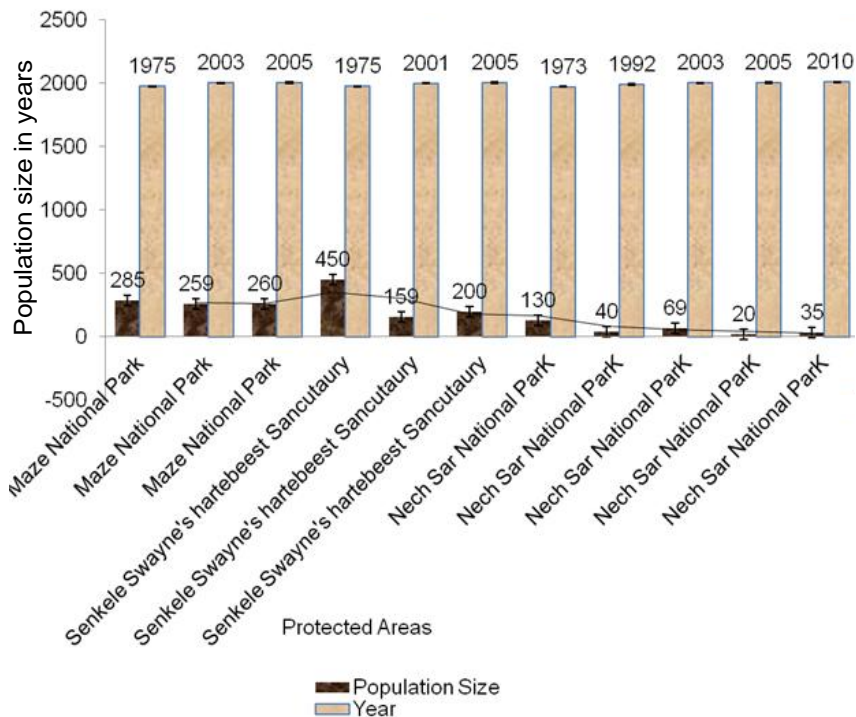
Figure 2. Swayne's Hartebeest Population size of the three protected areas during early 1970's and 2000's. (Sources: Bolton, 1973; Stephenson, 1975; Duckworth et al., 1992, 1993; Refera, 2005 Vymyslická et al., 2010, Fetene et al., 2011).

Population sex and age structures

During counting, the herd's sex and age composition was carefully observed. Sex identification was made for adults and sub-adults by observing primary sex characteristics. Indirect characteristics such as smaller body size in adult females as compared to adult males and reproductive behavioral characteristics were observed based on Lewis and Wilson (1979) and Messana (1993). Horns size and shape were also noted as horn in adult SHB females are more slender and less marked than in adult males (Gebre, 2000). The young male also has smaller body and horn sizes as that of the female but the presence of male reproductive organ such as scortum in young male and or udder around the genitalia in female aided in identification. While counting, four age groups were identified namely: Calf, Juvenile, Sub adult and adult. The horns can be compared based on Kok design (Kok, 1975). We classified the age group of the SHB according to Gebre (2000) in months: Calf (0 to 9), Juvenile (9 to 18), Sub-adult (18 to 30), and Adults (above 30 months).

Land cover change

For the land cover change identification, four imageries were acquired from Land Cover Facilities Archives for the periods 1986 and 2005 (NASA, 2005). Then a supervised image processing was undertaken using GRASS 6.4, which is an opens source GIS.

DATA ANALYSIS

A SPSS 15 software package was used to analyze the previous SHB population size, depict their trends from literatures, and to compute the correlation between the adult male and adult females of the PAs (Gebere, 2000; Mengesha and Bkele, 2008; Kumsa and Bekele, 2008). Moreover, both the SPSS and excel statistical software was used to estimate and analyze the population size from the current data and the different sex and age categories. The land cover analysis was carried out based on satellite imagery of Landsat (NASA, 2005).

RESULTS

This study revealed that the population size of SHB was fluctuating during the past 37 years (1973 to 2010) in the MaZNP, SHBS and NNP (Figure 2). They were decreasing from 865 individuals during 1975 with highest number in SHBS (450 individuals) to 480 individuals in 2005 with the highest number of individuals in the MaZNP (260 individuals). Between 1975 and 2010, the number of SHB was dramatically declining in the NNP from130 individuals in 1973 to 35 individuals in 2010 (Figure 2). Presently, a total of 840 individuals of SHB were recorded in the three Ethiopian protected areas. Of these, 364 occurred in the MaZNP, 464 in the SHBS and 12 individuals in the NNP (Table 1).

There were more adult male SHB recorded as compared to the female of the species consisting of 48% in MaZN, 39% in SHBS and 42% in NNP in the present study (Figure 3). The number of Juveniles were low in all

Table 1. Current population size, sex and age structures of Swayne's Hartebeest in the three Ethiopian Pas.

| PAs	Sex and age categories	N	df	Sum	Mean	95% Confidence Interval of the difference	
						Lower	Upper
Maze National Park	Adult male	6	5	172.00	28.67	-10.45	67.80
	Adult female	6	5	49.00	8.17	1.54	14.85
	Sub-adult	6	5	51.00	8.50	2.00	14.99
	Juvenile	6	5	25.00	4.17	1.24	7.09
	Calf	6	5	34.00	5.67	2.11	9.22
	Unknown	6	5	33.00	5.50	-2.34	13.35
	Sub-total	-	-	364	60.6	-5.88	127.00
Senkele Hartebeest Sanctuary	Adult male	6	4	180.00	30.33	2.54	49.46
	Adult female	6	4	154.00	26.00	5.03	56.57
	Sub-adult	6	4	71.00	11.83	8.62	19.78
	Juvenile	6	4	49.00	8.17	7.96	11.64
	Calf	6	4	10.00	1.67	-2.30	6.30
	Unknown	6	-	.00	.0000	.000	.000
	Sub-total	-	-	464	78	21.85	143.75
Nechsar National Park	Adult male	6	5	5.00	.8333	-.1985	1.86
	Adult female	6	5	4.00	.6667	-.1902	1.52
	Sub-adult	6	5	1.00	.1667	-.2618	.595
	Juvenile	6	5	1.00	.1667	-.2618	.595
	Calf	6	5	1.00	.1667	-.2618	.595
	Unknown	6	0	.00	.0000	.0000	.0000
	Sub-total	-	-	12	2.00	-1.17	5.17
	Total	-	-	840	140.6	14.9	276
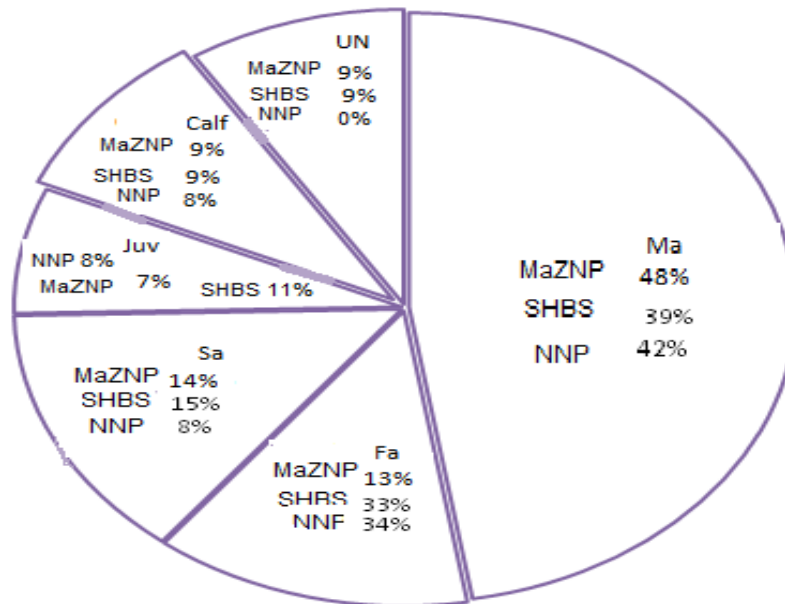
Figure 3. Percentage of sex and age composition of the SHB in the three protected areas. Note: MazNP=Maze National Park, SHBS=Swayne's Hartebeest Sanctuary, NNP= Nech Sar National Park.

Table 2. Relationships between the adult male and adult female of the three Ethiopian protected Areas.

Sex categories		Maze NP		Senkele SHBS		Nech Sar NP	
		AM	AF	AM	AF	AM	AF
AM	A Pearson correlation	1.00	.969**	1.00	.268	1.00	-.332
	Sig. (2-tailed)	-	.001	-	.663	-	.520
	N	6.00	6.00	5.00	5.00	6.00	6.00
AF	Pearson Correlation	.969**	1.00	.268	1.00	-.332	1.00
	Sig. (2-tailed)	.001	-	.663	-	.520	-
	N	6.00	6.00	5.00	5.00	6.00	6.00

Note: ** Correlation is significant at the 0.01 level (2-tailed) tailed). MazNP=Maze National Park, NechsarNP=National Park, AM= Adult male. AF=Adult female.

Table 3. The land cover changes between 1986 and 2005 in hactor and % in the three protected areas. Percentages are shown in the parenthesis.

PAs	Senkele SHBS		NNP		MaZNP	
Year	1986	2005	1986	2005	1986	2005
Grass	4,008(71)	3,823(67)	17,610 (37)	16,230 (34)	16,340 (75)	10,462(48)
Shrub	537 (9)	821 (14)	4,516 (9)	8,944 (19)	1,496 (7)	6,710 (31)
Woodland	1,128 (20)	1,029(18)	6,674 (14)	4,305 (9)	2,510 (12)	988 (5)
Forest	-	-	4,990 (10)	3,890 (8)	1,343 (6)	3,529 (16)
Water	-	-	14,265 (30)	14,687 (31)	-	-
Total area	5,673	5,673	48,056	48,056	21,689	21,689

the PAs studied (7% in MaZNP, 11% in SHBS and 8% in NNP) (Figure 3). The computed Pearson correlation for the relationship between the adult male and adult female SHB across the blocks showed high significant difference (2t= 0.969, P ≥ 0.01 level) for the MaZNP (Table 2). However, there was no significant difference between the adult male and adult female in SHBS and NNP (Table 2). Analysis of the available land cover map, namely, 1986 and 2005, of the MaZNP, SHBS and NNP have shown changing land cover of the PAs (Table 3, Figures 4, 5 and 6).

Tables 3, Figures 4, 5 and 6 show the major types of land or vegetation cover in the three PAs during 1986 and 2005. In MaZNP, from 1986 to 2005 the grassland decreased from 75 to 48%. On the other side, the shrub land increased from 7 to 31%. The total area covered by forest and woodland in 1986 is 18% of the area. In 2005, the forest and woodland cover was 21% of the area. In SHBS, both in 1986 and 2005, the major land cover was grassland. This class mainly includes grass covered areas and area used as cultivated land and open areas. The second major class of land cover is the woodland. The most important changes observed from 1986 to 2005 are an increase of the shrub land from 9 to 14%. In the NNP, the key land cover type during 1986 and 2005 is the grassland covering 37 and 34% of the area, respectively. The total area covered by the forest and

woodland in 1986 and 2005 was 24 and 17% of the area, respectively. An increase of the area covered by shrub was observed from 1986 to 2005 from 9 to 19% of the area.

Based on personal observation during the survey and also literatures searched, it was recognized that the size of the PAs was changing by re-demarcation in efforts for the conservation of the species by concerned authorities. Thus, there was better conservation endeavors in the SHBS and MaZNP. For instance, there was an increase in the size of SHBS from 36 to 57 km² and human activates was kept low in the MaZNP. Moreover the team observed poachers with automatic guns running to hide themselves from the teams in the MaZNP.

DISCUSSION

This study indicated that the number of individuals of SHB was fluctuating, increased in some of the years and decreased in the others between 1970s and 2010 (Figure 2). This is in agreement with the work of Easts (1999) that showed the decline in the individual number of the species and its fluctuation form one period in time to the other. This fluctuation and decline in number could be associated with the impacts of human activates that altered the historical vegetation cover of the Pas,
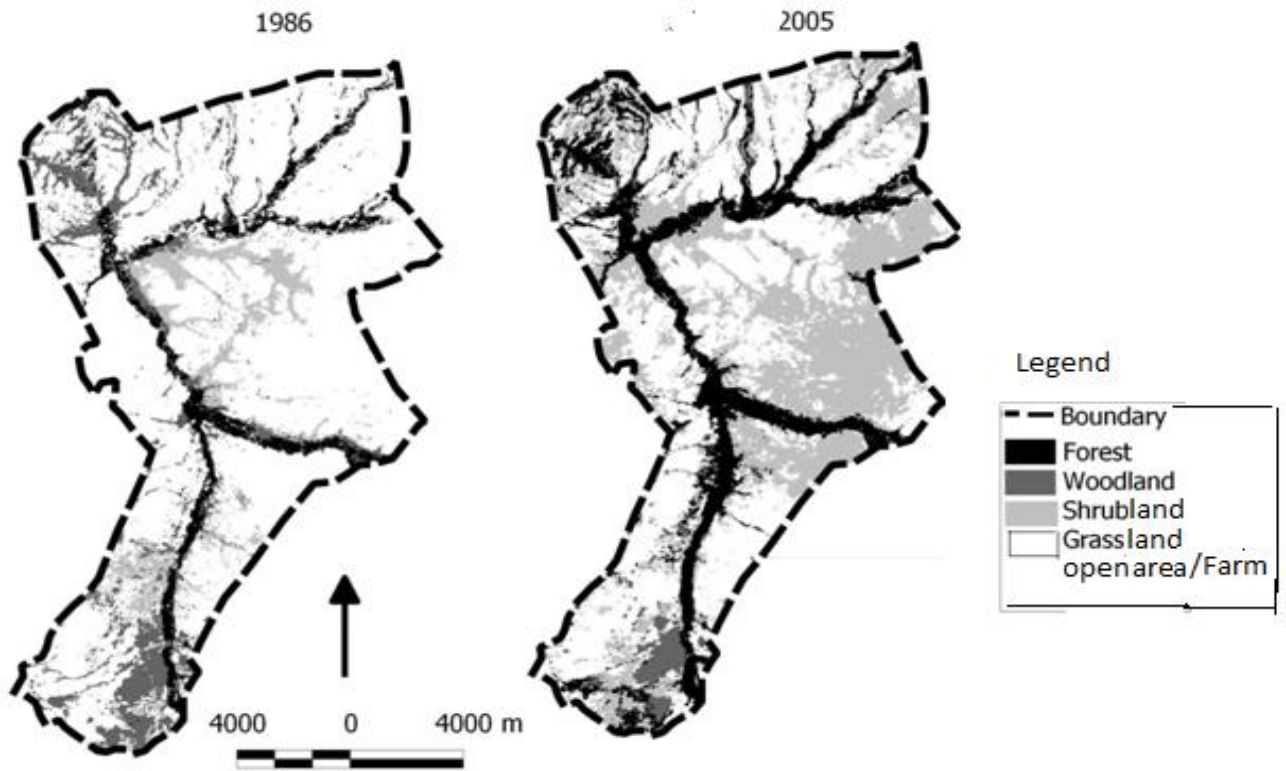
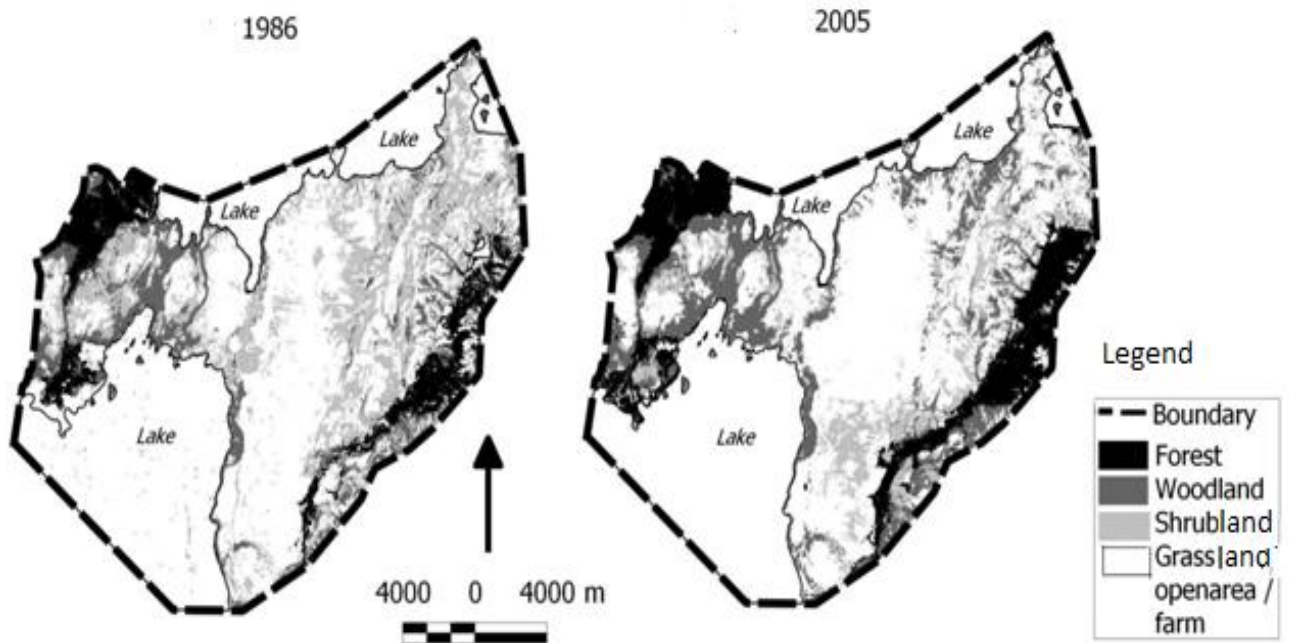**Figure 4.** Maze National Park land cove types of the 1986 and 2005.

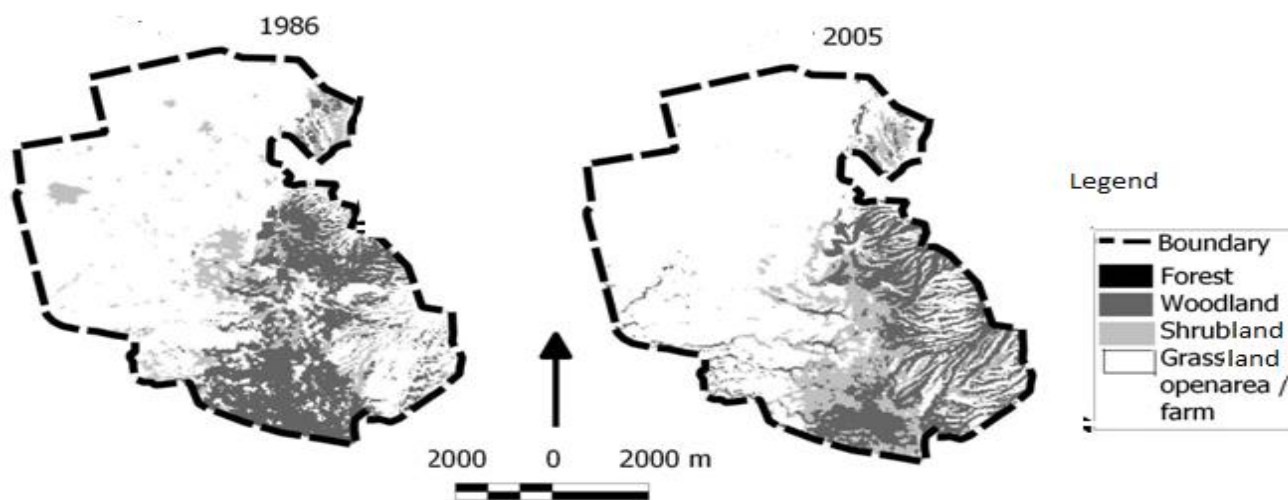**Figure 5.** Nechsar land cover type of the 1986 and 2005.

Figure 6. Senkele Swayne's Hartebeest sanctuary land cove type of the 1986 and 2005.

especially the grassland habitats into shrub and woodlands (Table 3, Figures 4, 5 and 6). This concurs with Bolton (1973), Stephenson (1975), Referea (2005), Kumssa and Bekele (2008) and Fetene et al. (2011) that indicated the impacts of human activities on the SHB in the PAs. Furthermore, the contraction and expansion of the size of the PAs might have also contributed to the fluctuation in the number of the hartebeest. Besides, currently there is an increase in the number of individuals of SHB in SHBS and MaZNP. This might be attributed to the conservation efforts in the PAs by the concerned authorities such as increase the size of SHBS and decreasing human activities that reduced grassland cover in the MaZNP. This is similar to the work of Andarge (2001), Refera (2005), Refera et al. (2003), Svialek (2008), Shimeles (2010), Fetene et al. (2011) and SHBS office report (2011) that showed an increase in the size of SHBS and reductions in the impact of human activities such as grazing in the PAs by their livestock resulted in an increase in population size of the SHB in the PAs. Moreover, the increase in the individual number of SHB in SHBS is in agreement with the work of Gebere and Yirga (2004) and Kumsa and Bekele (2008) that revealed increase of SHB in SHBS. Conversely, the SHB in the NNP dramatically decreased since early 1970s with increasing trends in some years to this study period (Figure 2 and Table 1). This is in line with Duckworth et al. (1992), Fetene et al. (2011) and Datiko and Bekele (2011) that showed the occurrence of 40 individuals in 1992, 35 individuals in 2011 and 12 individuals in 2011, respectively. One of the factors indicated for the dramatic decline in the NNP by the authors was overgrazing by the high livestock populations. This has reduced the grassland covers and increased the shrub lands leading to the dramatic decline in the meta-population of SHB in the NNP. Moreover, it has exposed the hartebeest to poaching and competition for grass with the livestock.

This agrees with Easts (1999), Jacobs and Schloeder (2001), Mengesha et al. (2009, 2008) that revealed the decrease in a number of individuals of a species in a protected area was associated to destruction of vegetation cover of the PAs.

The number of individuals of the male SHB was higher than the number of individuals of the females in the PAs (Figure 3). The highest proportion of adult male individuals of SHB in the three Ethiopian protected areas might be due to the adult male's ability to withstand and escape environmental threats such as decrease in grass cover and their better abilities to access such resources elsewhere compared to the females. This is similar to the work of Lewis and Wilson (1979), Messana (1993), Mamo et al. (2010), Fetene et al. (2011) and Datiko and Bekele (2011) that showed ability of larger adult male mammals to better tolerate environmental variables as compared to adult female of the species.

This study revealed that the number of individuals of adult males and females in the MaZNP showed a highly significant variation unlike the number of individuals of adult males and females in the SHBS and NNP. This variation might have occurred as a result of human activities that occasionally set fire that devastates the lowland vegetation cover of the MaZNP, the historical legal hunting and the current observed poaching activities by the local people called Bonna people. These could alter the behavior and distribution of the male and female animals within the MaZNP. This is in agreement with the work of Lewis and Wilson (1979), Messana (1993), Easts (1999) and Refera et al. (2003) that showed the effect of habitat destruction and poaching on the reproductive behavior and distribution of hartebeest in the protected area.

Conclusions

The study indicated that the numbers of individuals of SHB in the MaZNP, SHBS and NNP was fluctuating between the early 1970s and 2010. The trends in the population size of SHB in the PAs were unpredictable as their numbers increased in some of the years and decreased in others. The present investigation showed an increase in the numbers of individuals of SHB in the MaZNP and SHBS but dramatic decrease in the NNP. The factor identified was land cover change form more grass and woodland cover to shrub land type in the PAs. This meant that the original vegetation cover that support SHB was altered. The presence of more individuals of adult males as compared to the female and the fewer juveniles than adults, sub adults and calves in all the PAs showed declining population. Therefore, urgent conservation measures that reduce the threat to the endemic species and increases their population size is needed to conserve the species in Ethiopia.

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